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1. A metadata model transformer for transforming a metadata model, the metadata model having a lower layer containing one or more lower abstraction model objects having a lower abstraction level and a higher layer containing one or more higher abstraction model objects having a higher abstraction level, the transformer comprising:
- 5 a lower-to-higher transformation having:
- means for obtaining information of a lower abstraction model object from the lower layer;
- 10 means for abstracting the information by adding business intelligence; and
- means for creating in the higher layer a higher abstraction model object corresponding to the lower abstraction model object.
2. A metadata model transformer as claimed in claim 1 further comprising:
- 15 a lower layer transformation having:
- means for obtaining information of a lower abstraction model object from the lower layer;
- means for modifying the obtained information; and
- 20 means for transforming the lower abstraction model object based on the modified information.
3. A metadata model transformer as claimed in claim 1 further comprising:
- 25 a lower layer transformation having:
- means for obtaining information of a lower abstraction model objects from the lower layer;
- means for determining a specific feature included in the obtained information; and
- 30 means for creating a new lower abstraction model object based on the specific feature.
4. A metadata model transformer as claimed in claim 1 further comprising:
- a lower layer transformation having:
- means for obtaining relationship information between multiple lower abstraction model objects from the lower layer; and
- 35 means for creating a new lower abstraction model object based on the relationship information.

5. A metadata model transformer as claimed in claim 1 further comprising:  
a higher layer transformation having:  
means for obtaining information of a higher abstraction model object from  
the higher layer;  
means for modifying the obtained information; and  
means for transforming the higher abstraction model object based on the  
modified information.
6. A metadata model transformer as claimed in claim 1 further comprising:  
a higher layer transformation having:  
means for obtaining information of a higher abstraction model objects from  
the higher layer;  
means for determining a specific feature included in the obtained  
information; and  
means for creating a new higher abstraction model object based on the  
specific feature.
7. A metadata model transformer as claimed in claim 1 further comprising:  
a higher layer transformation having:  
means for obtaining relationship information between multiple higher  
abstraction model objects from the higher layer; and  
means for creating a new higher abstraction model object based on the  
relationship information.
8. A metadata model transformer as claimed in claim 1 further comprising:  
a higher layer transformation having:  
means for selecting a subset of the higher abstraction model objects from  
the higher layer; and  
means for creating a new higher abstraction model object based on the  
selected subset of the higher abstraction model objects.
9. A metadata model transformer for transforming a metadata model that represent  
one or more data sources having physical data, the metadata model having a data  
access layer containing data access model objects, a business layer containing business  
model objects, and a package layer containing package model objects, the transformation

comprising:

one or more data access model transformations for refining description of the physical data in the data source expressed by the data access model objects;

one or more data access to business model transformations for constructing business model objects based on the data access model objects;

one or more business model transformations for refining the business rules expressed by the business model objects; and

one or more business to package model transformations for constructing package model objects based on the business model objects.

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10. A metadata model transformer as claimed in claim 9, wherein the data access model transformations refine the description by adding new data access model objects to data access model objects which are constructed via import from the data sources or one or more metadata sources.

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11. A metadata model transformer as claimed in claim 9, wherein the business model transformations refine the business rules by changing the business model objects.

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12. A metadata model transformer as claimed in claim 11, wherein the business model objects include business model objects which are constructed via import from one or more metadata sources.

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13. A metadata model transformer as claimed in claim 9 further comprising:  
one or more package model transformations for constructing a new package layer based on the package model objects in the model.

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14. A metadata model transformer as claimed in claim 13, wherein the package model objects include package model objects which are constructed via import from one or more metadata sources.

15. A metadata model transformer as claimed in claim 9 further comprising:  
a name mutation transformation for changing names of objects in the model based on user defined rules.

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16. A metadata model transformer as claimed in claim 9, wherein the data access model transformations include a transformation which creates a new data access model

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object based on the data access model objects contained in the data access layer.

17. A metadata model transformer as claimed in claim 16, wherein

the data sources contain tables having columns and indexes;

the data access model objects include data access tables, data access columns and data access indexes which respectively describe information about the tables, columns and indexes in the data sources; and

the data access model transformations include a data access join constructing transformation for constructing a data access join between data access tables based on the data access indexes.

18. A metadata model transformer as claimed in claim 16, wherein

the data sources contain tables having columns and indexes;

the data access model objects include data access tables, data access columns and data access indexes which respectively describe information about the tables, columns and indexes in the data sources; and

the data access model transformations include a data access key constructing transformation for creating a data access key for a data access table based on the data access indexes.

19. A metadata model transformer as claimed in claim 16, wherein

the data sources contain at least one of tables having columns and indexes, views having columns or files having columns or fields;

the data access model objects include at least one of data access tables, data access views, data access files, data access columns and data access indexes which respectively describe information about the tables, columns of the tables, indexes of the tables, the views, the columns of the views, the files, and the columns or fields of the files in the data sources; and the data access model transformations include a table extract constructing transformation for constructing a table extract based on the data access tables, the data access views and the data access files.

20. A metadata model transformer as claimed in claim 16, wherein

the data access model objects include one or more logical cube, each of which defines a multidimensional space represented in a number of physical storage formats; and

the data access model transformations include a data access cube constructing

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transformation for constructing data access cubes to instantiate the multidimensional space defined by each logical cube.

21. A metadata model transformer as claimed in claim 9, wherein the data access to  
5 business model transformations include a basic business model constructing transformation which obtains information about a data access model object in the data access layer, and create a business model object corresponding to the data access model object.

22. A metadata model transformer as claimed in claim 21, wherein  
the business model objects include entities that exist as an implementation artifact of a many to many relationship, and many to many business joins associated with the entities; and

the business' model transformations include a many to many join relationship  
15 fixing transformation for locating the entities, and replacing the associated many to many business joins with a single business join.

23. A metadata model transformer as claimed in claim 21, wherein  
the business model objects include entities that are related via a 1:1 join  
20 relationship; and

the business model transformations include an entity coalescing transformation for locating the entities that are related via a 1:1 join relationship, and coalescing the located entities into a single entity.

24. A metadata model transformer as claimed in claim 21,  
the business model objects include one or more redundant joins that express the transitivity of two or more other join relationships in the business layer; and

the business model transformations include a redundant join relationship  
eliminating transformation for locating the redundant joins, and eliminating the redundant  
30 joins from the business layer.

25. A metadata model transformer as claimed in claim 21, wherein  
the business model transformations include a subclass relationship introducing transformation for introducing a new entity with a subclass relationship into the business  
35 layer.

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the business model transformations include an entity referencing transformation for locating the entity acting as a lookup table, and changing the business join which is an association type to a business join which is a reference type.

15 the business model transformations include a date usage identifying transformation for examining attributes to determine where dates are used in the attributes.

25 transformations include a special package construction transformation for constructing a  
specific package which is usable by a specific client application from a generic package.

32. A metadata model transformer as claimed in claim 31, wherein the multidimensional model transformations include a measure identifying and measure dimension constructing transformation for analyzing the structure of each data source to identify entities that contain measure candidates and identifying a reasonable set of measures.

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38. A method as claimed in claim 36, wherein the step of refining the business rules comprises a step of changing the business model objects.

Figure 1 consists of 12 histograms arranged horizontally. Each histogram represents the frequency distribution of the number of non-zero elements in the vector  $x$  for a specific value of  $n$ . The x-axis for all histograms is 'Number of non-zero elements in  $x$ ' with major ticks at 0, 20, 40, 60, 80, 100, and 120. The y-axis is 'Frequency' with major ticks at 0, 2, 4, 6, 8, and 10. The histograms are labeled with  $n$  values: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, and 120. As  $n$  increases, the distribution becomes more concentrated around  $n$ , and the peak frequency increases.

39. A method as claimed in claim 36, wherein the step of refining the business rules uses the business model objects that include business model objects which are constructed via import from one or more metadata sources.

40. A method as claimed in claim 36, further comprising a step of constructing a new package layer based on the package model objects in the model.

41. A method as claimed in claim 40, wherein the step of constructing a new package layer uses the package model objects that include package model objects which are constructed via import from one or more metadata sources.

42. A method as claimed in claim 36 further comprising a step of changing names of objects in the model based on user defined rules.

43. A computer readable memory for storing code which identifying instructions for transforming a metadata model for containing model objects, the metadata model having multiple layers including a lower layer containing one or more lower abstraction model objects having a lower abstraction level and a higher layer containing one or more higher abstraction model objects having a higher abstraction level, the instructions comprising:  
 obtaining information of a lower abstraction model object from the lower layer;  
 abstracting the information by adding business intelligence; and  
 creating in the higher layer a higher abstraction model object corresponding to the lower abstraction model object.

44. A computer data signal representing code which identifying instructions for transforming a metadata model for containing model objects, the metadata model having multiple layers including a lower layer containing one or more lower abstraction model objects having a lower abstraction level and a higher layer containing one or more higher abstraction model objects having a higher abstraction level, the instructions comprising:  
 obtaining information of a lower abstraction model object from the lower layer;  
 abstracting the information by adding business intelligence; and  
 creating in the higher layer a higher abstraction model object corresponding to the lower abstraction model object.